An account is given of experiments to determine the tolerance of groups of men to such tensions of oxygen under varying conditions.

The signs and symptoms of oxygen poisoning in man are described.

The possibility of pulmonary damage by increased tensions of oxygen is discussed.

Electrical and chemical changes in the central nervous system are briefly described.

The relation of oxygen poisoning to epilepsy and the possibilities of further useful investigations are discussed.

The danger of breathing oxygen at increased tensions is emphasized.

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The British Legion Unit of Rheumatology, set up experimentally by the British Legion a year ago, to specialize in the treatment of ex-Servicemen and women suffering from rheumatic diseases, has now been transferred, complete with staff, from the Three Counties Hospital, Arlesey, Beds., to the North-West Hospital, Haverstock Hill, London, N.W.1. The Minister of Health has agreed to take over the unit on May 31, and to encourage the provision of further units throughout the country.

ACUTE NON-SPECIFIC DIARRHOEA AND DYSENTERY

LOCAL CHILLING OF THE ABDOMEN AS A CAUSATIVE FACTOR

BY

G. R. KERSHAW, M.A., M.R.C.S., L.R.C.P.

Acute enteritis of unknown origin is common in Europeans visiting and living in hot climates. It is so common and so widespread that the lay public in every country use a colloquialism peculiar to their district to describe the local manifestation of a complaint which, though second only to sea-sickness in its power of temporary prostration, seldom lasts more than a few days, so that it is soon forgotten or is accepted as a perennial part of the white man's burden. Its social and economic consequences, though brief, are severe to the individual, but its military consequences can be disastrous to a community of fighting-men: apart from jeopardizing a single operation there is nothing so calculated to lower morale as recurrent attacks of diarrhoea.

In the intervals it is made light of by the public and is rarely considered seriously by the profession. Not all standard textbooks or monographs even refer to it, and in those that do so it is seldom discussed at a length which suggests that it is probably the illness encountered most commonly among the white population in hot climates. Even the most reputable authors, moreover, show little confidence, agreement, or justification in describing its cause, and still less in recommending prophylactic measures. It is ascribed variously to "exposure to chill, and irritation of the bowel by coarse and unsuitable food" (MacArthur, 1942), to potentially pathogenic bacteria (McDonagh, 1942), to "the recognized dysentery organisms, precipitated by sudden chilling" (Napier, 1946), and as "probably bacterial in origin" (Manson-Bahr, 1945). Macgregor (1946) gives good reasons for this dissatisfaction with the traditional causes and, after showing a close association in time with acute upper respiratory disease, favours a virus infection, on the principles believed by Burns and Gunn (1944) to cause diarrhoea in infants, as described in a *B.M.J.* editorial (1942).

Opinion is, therefore, overwhelmingly in favour of infection, and this belief is based on three main points: (1) Its symptomatology is similar to that due to known pathogens. (2) It occurs in outbreaks as well as sporadically. (3) In the many outbreaks of enteritis of unknown cause during the war it has been shown that the more thorough the investigation the more often is a known pathogen recovered (Hardy and Watt, 1945). Similar symptomatology, however, is known to occur with any form of irritation within the lumen of the gut, and its simultaneous appearance in different people is by no means necessarily indicative of infection; while to attribute the disease to an unknown organism which has never been demonstrated is to admit to a degree of professional complacency which is as astonishing as it is unscientific.

Chilling of the Abdomen

Perhaps equally unscientific, but of longer duration, is its traditional association with chill. In some (MacArthur, 1942; Napier, 1946) references to acute enteritis exposure to chill, in quite general terms, is mentioned as a probable factor in its cause, either predisposing or actual; this appears to have passed from one book to another without much consideration or justification. Now it is in fact a matter of common knowledge that *chilling of the abdomen* by the rapid ingestion of cold fluid in large quantities when the body is hot does often induce diarrhoea, and it is fairly

well recognized that *chilling of the anterior abdominal wall* frequently does likewise. Too much ice-cream or too long an iced drink, or moderate amounts of either taken quickly instead of by sips, are methods of provoking diarrhoea as proverbial as that of allowing a wet bathing costume to "dry on" while sun-bathing. Bampfield (1819) wrote as follows:

"The copious perspiration of the newly arrived European becomes accumulated, when he is sitting or walking, on the lower part of the shirt, more especially about that part of the abdomen where the waistband of the small clothes or pantaloons presses against it, the tight or close application of which occasions an increase of heat and of perspiration at this particular part, during the day, and intercepts the exhalation as it flows down the body; hence, if he should lie down in this state, cold will be induced on a particular part of the abdomen, by the evaporation of the exhaled fluid from the wet linen in contact with it; perspiration, before profuse, will be now effectually suppressed, and its injurious consequences felt by the chylopoietic viscera."

Johnson and Martin (1841) introduce this quotation to their readers by saying: "We do not recollect that the following circumstance has ever been noticed heretofore as a predisposing cause of dysentery." McDowall (1927) writes:

"The wearing of so-called cholera belts signifies the importance of keeping this particular region of the body (the abdomen) warm, for the alimentary canal is a region especially liable to be infected as a result of cold. The production of diarrhoea or the return of symptoms after an attack of dysentery, which may follow a cold bath or sea-bathing, has long been recognized."

Hints to Travellers (1938) states that "A drop in the night temperature in the Tropics constitutes another danger, so protect the abdomen with warm clothing at night time," and it advises the traveller to "consider . . . also the liability to chill, and whether the often derided cholera belt is essential." Napier (1946) writes:

"The flannel cholera belt, whose powers of cholera prevention were of course mythical but which could be guaranteed to produce a nice band of prickly heat in most climates, has fortunately gone out of fashion. Quiescent abdominal infections are sometimes stimulated into activity by local chilling which the cholera belt was designed to obviate; it is therefore advisable for those subject to attacks of diarrhoea to put wraps round their abdomens, rather than over their shoulders, when cooling off after exercise."

Physiological Deductions

Better understanding of physics and physiology enables the present-day physician to appreciate that, owing to the high latent heat of steam, the anterior abdominal wall is seldom more chilled than by the evaporation of sweat, and also that as the temperature of the air rises so does the proportion of body heat lost by evaporation, to the eventual exclusion of other methods. He can furthermore predict other factors which will influence this process—namely, the humidity of the air and the velocity of air movement.

Diarrhoea is therefore to be expected in those entering a hot climate from a cold one, whose thinner clothes afford less protection from the cool evening breeze to an abdomen accustomed to thicker and warmer clothes; whose garments in the heat of the day cling to the abdominal wall, where they lie closest to the body, and provide a system whereby the greater the temperature the more body heat shall be lost through this vulnerable surface. It is to be expected that residents in hot climates should suffer frequently from diarrhoea while they are continually exposed to the same conditions, that the frequency of attacks should be highest in the early months of summer (Northern Hemisphere), when the diurnal variation in temperature is greatest, and in the autumn or rainy season, when a higher humidity causes the body surface to be covered with a film of perspiration at moderate or similarly varying temperatures.

Clinical Observations

Too many have ample (and painful) experience that these expectations are often fulfilled; some clinical observations made in H.M. ships during the war may, however, provide more acceptable evidence than personal reminiscence. Typically the patient was awakened shortly after midnight with generalized abdominal colic and an urgent call to defaecate; vomiting was rare and tenesmus absent. In mild cases a few loose stools and waning bouts of colic saw the end of the attack by the following midday, but in severe cases the colic persisted and the stools became watery, progressing even to mucous and blood-stained, and the course lasted several days with marked prostration and anorexia and a slightly raised temperature. Spontaneous recovery was rapid and complete.

Sporadic cases were frequently observed to occur, more often in warm climates than in cold, among those working in parts of the ship where the temperature, air velocity, and humidity were highest, and in those wearing unsuitable clothing—for example, overalls without undergarments, shrunken sheepskin waistcoats; and, until recognized, a central source of cold drinking-water proved to be the cause of this complaint also in hot weather. The frequency of small and large outbreaks was remarkable and in contrast to the exceptional rarity with which known pathogens were detected upon appropriate bacteriological investigation when this could be undertaken; moreover, not one corresponded epidemiologically in any way to the expected features of disease borne by water, food, insects, or droplet infection. It will be appreciated that distilled water was used nearly always, and that analysis of water from the storage tanks was rarely performed but never suggestive. Outbreaks usually started during the night, mostly throughout the hotter months of the year, with a first peak in early summer and a second, and larger, peak in the "sticky" period of early autumn. Three major outbreaks were observed: before landfall at the end of quick passages from England to the Eastern Mediterranean; during unaccustomed and exceptionally cold weather in Arctic waters; and on passage through the Suez Canal from South to North.

Investigations

The routine and repeated examination of patients' stools was carried out whenever facilities were available. In the course of three and a half years I recollect only one case being diagnosed by laboratory methods as a specific infection. No other significant findings were reported.

Water.—It will be appreciated that the water consumed on board was nearly always distilled in the ships, but sometimes obtained from a certified source ashore. The fresh-water storage tanks were cleaned and relined without any alteration in the incidence of the attacks, and two analyses of the water showed nothing suspicious in content or in comparison.

Food.—Most food was stored up to three months, but meat consumed after three years in the cold-store did not alter the incidence, nor did the lack of fresh fruit and vegetables during a period of some months. Tinned food was mostly uncrated and some tins were badly dented, but blown or doubtful ones were discarded. Attacks of enteritis were not associated with any particular foodstuffs, and those who had had their evening meal ashore were equally affected.

Food preparation and handling.—No history of specific intestinal infection was obtained from the cooks, and they were from time to time victims of the outbreaks themselves. Food was prepared centrally, in one large galley, and in three small ones contained in a separate compartment; it was

prepared for immediate use only. The temperature of the water used for the washing of cooking and eating utensils was always over 130° F. (55° C.) and usually very much hotter.

Droplet infection and insect vectors.—The incidence of attacks was not associated in time with that of either acute upper respiratory disease or sandfly fever. Close contact between cases was not a feature of the disease, and the incidence was not higher among the sick-berth staff who slept in the sick-bay than in others. The peaks of the attacks corresponded with the maximum prevalence of flies, but attacks occurred when flies were altogether absent; cockroaches abounded at all times in the galleys and pantries.

While the practice of hygiene and the limitations of investigation by operational conditions were open to criticism, conditions were sufficiently sterile, metaphorically if not bacteriologically, to warrant attention being turned to chilling of the abdomen as a possible factor in causation. In fact the association was noticed early and the more often it was sought the more frequently it was found, until in the explosive outbreaks it was observed so constantly that it was established beyond doubt. It has been said that attacks began typically soon after midnight and affected those who ate their evening meal ashore or those joining ship in the afternoon as frequently as those whose shore-leave had been stopped for many days. The only common factors remaining were the cool of the evening and the first few hours of sleep; the majority of ratings slept in hammocks, and hammocks were slung from the deckhead—the very place where the cool night air was introduced into all living spaces below deck by an extensive plenum system of ventilation.

Plenum Ventilation in Ships

This extreme frequency in ships was generally attributed to the plenum system of ventilation. The overcrowding of troopships was a notorious necessity, and in one warship in which many of these observations were made Sir Sheldon Dudley's (1946) appreciation of the spatial restrictions was by no means an overestimate, for in many compartments both the space per man and the number of air changes were half those intended at the very times they should have been liberal. The dry-bulb temperature of a forward mess deck when unoccupied, in one ship, was observed to be 90° F. (33° C.) in November evenings in the Western Mediterranean and in another ship to be constantly between 90° and 110° F. (43° C.) in a cabin amidships during four summer months in two consecutive years. In consequence working or resting in comfort was possible in some instances only so long as the louvre was pointing towards the body, the anterior surface giving the greatest relief; while at night, with blackout restrictions added, a few hours' rest was achieved only by lying (often with overalls rolled down to the waist) within a few feet of the louvre—a unique arrangement, since hammocks must be slung from the deckhead of living-spaces, where the plenum apparatus is properly spaced to avoid this very same effect by day. Ratings continued, even after being advised against it, to sleep wearing overalls rolled down to the waist with no other covering, and in cabins it was a common practice to direct the flow of air to the bunk by tying pyjama trousers to the louvre. In the explosive outbreaks the ratings who slept in hammocks suffered much more frequently, more severely, and earlier than those who slept on camp-beds. It is pertinent to add here that in the previously mentioned outbreak in Arctic waters one victim was an officer, keeping a night watch in an exposed position, who was wearing a very shrunken sheepskin waistcoat.

The presentation of these few clinical observations in logical sequence may carry conviction that chilling of the abdomen or anterior abdominal wall is a common cause of acute non-specific enteritis ashore and afloat in all climates, but especially hot ones.

Prophylactic Measures

Whether it is the predisposing or actual cause is for practical purposes unimportant in the present state of medical knowledge, for prophylactic measures against this disease are not only common-sense but calculable. On entering a hot climate suddenly, which air travel will render more frequent in future, the change from thick to thin clothes should be made gradually, if possible, and an undervest worn and exercise avoided until acclimatization is achieved. During residence a bush-shirt, or a loose-fitting shirt with cellular undervest, should be worn, and a change to thicker clothes, if at all possible, made before sundown. An undervest should be worn, especially in spring and autumn and in windy or humid weather. Cool drinks should be sipped slowly by day, and sitting in the direct draught of forced ventilation for long periods should be avoided.

The plenum system as arranged in living-spaces for daytime usage is unsuitable for the ventilation of sleeping accommodation where hammocks or tier bunks are employed. By night a cholera belt or a blanket folded across the abdomen should be worn with or without other bedclothes.

Whatever the mechanism of the predisposing cause, opinion is still overwhelmingly in favour of infection being the actual cause. The obstinacy with which this belief is held without any basis in fact amounts to bigotry; until such an organism is demonstrated it would be at least reasonable to attribute the enteritis to a change in the oecology of the intestinal tract, which might fairly be presumed to be a sequel to vascular reflexes stimulated by chilling, but there is as yet, I believe, no evidence to show that it is not attributable to either neuromuscular reflexes or even purely physical causes such as chilling or salt deficiency (Stenning, 1945). Since it is evident that no further progress is likely from clinical observations there is here a strong case for experimental research.

Summary

Acute non-specific enteritis is common in hot climates. Its social and military consequences are important.

Its cause is subject to dispute, and prophylaxis is uncertain.

Local chilling of the abdomen is a known cause of diarrhoea. Circumstances causing local chilling are common, still more common in hot climates, and extreme in overcrowded ships. Examples attributed to this cause are given.

Prophylactic measures are deduced.

A plea is made for experimental research.

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